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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application]This invention relates to the color liquid crystal display of a RGB field sequential display type which prevented muddiness or mixed colors of the foreground color.
[0002]
[Description of the Prior Art]Generally, when an electrochromatic display display device is compared with a color CRT etc., it has the problem that the resolution is low and cannot display a quality color picture easily. This fault is solved and the color liquid crystal display of the RGB field sequential display type (three-primary-colors sequential display type) attracts attention as art which improves the resolution on the appearance of a liquid crystal display element. This method arranges the disc-like light filter 33 which equips the rear-face side of the liquid crystal display element 31 of monochrome gradation display with the field of R (red), and G (green) and B (blue) so that it may illustrate to drawing 10, A color picture is obtained by rotating this light filter 33 synchronizing with the image display of the liquid crystal display element 31, and irradiating the liquid crystal display element 31 with the light from the light source 35 via the light filter 33. According to this method, the pixel number and numerical aperture on the appearance of the liquid crystal display element 31 can be increased 3 times of a actual value, and the color picture of high resolution can be displayed.
[0003]
[Problem(s) to be Solved by the Invention]However, in the color liquid crystal display of the RGB sequential method shown in drawing 10. Each field of the light filter 33 is fanning, and the line (a horizontal scanning line, a scan line) of the liquid crystal display element 31 and the boundary (boundary of a color) of each field of the light filter 33 do not become parallel in the upper bed part and lower end part of the liquid crystal display element 31. For this reason, the color which is in the pixel of the 1st line of the liquid crystal display element 31 so that it may

illustrate to drawing 11 (A) (by a diagram) R) It is the color (by a diagram) of the light filter 33 on the liquid crystal display element 31 from from [before writing in the picture of business]. the color (a figure R) which is in the pixel of the line of the lowermost end of the liquid crystal display element 31 so that the field of R) may be located or it may illustrate to drawing 11 (B) -- also after writing in the picture of business, the field (a figure B) in front of the light filter 33 is located on the liquid crystal display element 31. Therefore, a picture will be temporarily displayed in a color other than a color to display originally, mixed colors will happen, and a foreground color will become muddy.

[0004]This invention is made in view of the above-mentioned actual condition, and is a thing. The purpose is to provide the color liquid crystal display of the RGB field sequential display type which can display a color picture by a color without muddiness.

[0005]

[Means for Solving the Problem]In order to attain the above-mentioned purpose, a color liquid crystal display of a RGB field sequential display type concerning this invention, A liquid crystal display element which displays colorless gradation images for [trichromatic / each] the colors for forming a compounded color picture, It is arranged at the surface [of said liquid crystal display element], or rear-face side, the trichromatic field is arranged in predetermined turn, a boundary part of each field is substantially equipped with a black mask, and it is constituted more with a light filter which rotates synchronizing with display timing of a picture of said liquid crystal display element.

[0006]

[Function]Since the shape of each field is fanning by having the above-mentioned composition, for example according to the color liquid crystal display of the RGB field sequential display type of this invention, Since the black mask is arranged between the fields also when each line (horizontal scanning line) of a liquid crystal display element and the boundary of each field are non parallel, being expressed as a color to display a picture on originally and a different color is lost. Therefore, muddiness of the color of a display image can be prevented.

[0007]

[Example]Hereafter, one example of this invention is described with reference to drawings. Drawing 1 shows the composition of the color liquid crystal display of the RGB field sequential display type concerning this example. So that it may illustrate the color liquid crystal display of this RGB field sequential display type, The liquid crystal display element 11 and the light filter 13 arranged at the rear-face side of the liquid crystal display element 11, It has the light source 15 arranged at the rear-face side of the light filter 13, the motor 17 made to rotate the light filter 13, the liquid crystal actuator 19 which displays monochrome gradation images on the liquid crystal display element 11, and the roll control part 21 which rotates the motor 17 and rotates

the light filter 13.

[0008]The liquid crystal display element 11 comprises a ferroelectric liquid crystal display device (liquid crystal display element using the ferroelectric liquid crystal as a liquid crystal) etc. in which a high speed response is possible, for example, and performs monochrome (colorless) gradation display. The frame frequency of the display image of the liquid crystal display element 11 is 180 Hz, for example.

[0009]Next, an example of the concrete composition of the liquid crystal display element 11 is explained. The top view of the substrate with which drawing 2 formed the sectional view of the liquid crystal display element 11, and drawing 3 formed the picture element electrode and active element of the liquid crystal display element, and drawing 4 are the figures showing the relation between the orientation direction of a liquid crystal element, and the optical axis of a polarizing plate.

[0010]This ferroelectric liquid crystal display device is a thing of an active matrix.

Array forming of the thin film transistor (following, TFT) connected to the lower picture element electrode 103 and the picture element electrode 103 transparent to the substrate (the following, lower substrate) 101 in drawing 2 among the transparent substrates (for example, glass substrate) 101 and 102 of a couple is carried out to matrix form.

As shown in drawing 3 at the lower substrate 1, the gate line (scan line) 105 is wired by the spacing of the picture element electrode 103, and the data line (gradation signal line) 106 is wired between the sequences of the picture element electrode 103. The gate electrode of each FTF104 is connected to the corresponding gate line 105, and the drain electrode is connected to the corresponding data line 106.

[0011]The gate line 105 is connected to the line drivers (line drive circuit) 121 via the terminal area 105a, and the data line 106 is connected to the column driver (sequence drive circuit) 122 via the terminal area 106a. The line drivers 121 impress a gate pulse and scan the gate line 105. On the other hand, the column driver 122 receives an indicative data (gradation data) from the liquid crystal actuator 21, and the data signal corresponding to an indicative data is impressed to the data line 106.

[0012]In drawing 2, each picture element electrode 103 of the lower substrate 101 and the transparent counterelectrode 107 which counters are formed in the upper substrate (the following, upper substrate) 102. The counterelectrode 107 comprises an electrode of one sheet of the area covering the whole viewing area, and the fixed reference voltage V0 is impressed.

[0013]The orienting films 108 and 109 are formed in the electrode formation face of the lower substrate 101 and the upper substrate 102, respectively. The orienting films 108 and 109 consist of organic polymer compounds, such as polyimide, and orientation treatment, such as rubbing, is performed to the opposed face.

[0014]The lower substrate 101 and the upper substrate 102 are pasted up via the sealant 110 of frame shape in the outer periphery part.
The liquid crystal 111 is enclosed with the field surrounded by the sealant 110 between the substrates 101 and 102.
The liquid crystal 111 has a spiral pitch of a chiral smectic C phase smaller than the interval of both the boards 101 and 102, and is a ferroelectric liquid crystal (henceforth, DHF liquid crystal) which does not have the memory nature of an oriented state. The DHF liquid crystals 111 are 700 nm - 400 nm or less (for example, 400 nm - 300 nm) whose spiral pitches are the wavelength of a visible light pattern region.
Spontaneous polarization is large and a corn angle consists of a ferroelectric liquid crystal composition (about 27 degrees thru/or 45 degrees (desirably 27 degrees thru/or 30 degrees)).
The layer thickness of the liquid crystal 111 is held by the sealant 110 and the transparent gap material 112 at constant value. The gap material 112 is arranged in the state of scattering in the liquid crystal encapsulating region.
[0015]The DHF liquid crystal 111 turns the normal of the layer of the layer system which a chiral smectic C phase has towards the orientation treatment of the orienting films 108 and 109, and forms a uniform layer system. Since the spiral pitch is smaller than a substrate interval, where it has spiral structure, it is enclosed between the substrates 101 and 102. When the voltage whose absolute value is higher than a predetermined value is impressed between the picture element electrode 103 and the counterelectrode 107 which counter on both sides of a liquid crystal layer, The DHF liquid crystal 111 is set as either state of the 1st oriented state in which a liquid crystal element carries out orientation to one way, and the 2nd oriented state in which a liquid crystal element carries out orientation for another side according to the polarity of impressed electromotive force, When the voltage whose absolute value is lower than said predetermined value is impressed between the impression picture element electrode 103 and the counterelectrode 107, and the spiral of the DHF liquid crystal 111 is distorted, the average array state of a liquid crystal element will be in the 1st and the middle state of the 2nd oriented state according to impressed electromotive force.
[0016]The polarizing plates 113 and 114 of the couple are arranged at the upper and lower sides of the liquid crystal display element. The direction of the transmission axis of the polarizing plates 113 and 114 is set up according to the orientation direction of the liquid crystal element of the DHF liquid crystal 111 in the above-mentioned 1st and the 2nd oriented state.
[0017]The relation between the transmission axis of the polarizing plates 113 and 114 and the orientation direction of the liquid crystal element of the DHF liquid crystal 111 is explained with reference to drawing 4. Drawing 4 (a) shows the transmission axis 114a of the upper polarizing plate (the following, upper polarizing plate) 114 in drawing 2, (b) shows the average orientation

directions 111a and 111b of the liquid crystal element in the 1st and the 2nd oriented state of the DHF liquid crystal 111, and (c) shows the transmission axis 113a of the lower polarizing plate (the following, lower polarizing plate) 113 in drawing 2.

[0018]It is one polarity, and when the voltage more than a value predetermined in an absolute value is impressed, it will be in the 1st oriented state of the DHF liquid crystal 111, and the average orientation direction of a liquid crystal element turns into the 1st orientation direction 111a shown in drawing 4 (b) as a solid line. It is the polarity of another side, and when the voltage more than a value predetermined in an absolute value is impressed, the DHF liquid crystal 111 will be in the 2nd oriented state, and the average orientation direction of a liquid crystal element turns into the 2nd orientation direction shown in drawing 4 (b) with a wavy line. Although the gap angle theta of the 1st orientation direction 111a and the 2nd orientation direction 111b changes with kinds of DHF liquid crystal 111, it is selected by 25 degrees - 45 degrees, and are 27 degrees - 45 degrees desirably.

[0019]As for the transmission axis 114a of one polarizing plate 114, for example, an upper polarizing plate, on the other hand, the two orientation directions 111a and 111b of the DHF liquid crystal 111 are set up almost in parallel with the 2nd orientation direction 111b among the polarizing plates 113 and 114 of a couple.

The transmission axis 113a of the lower polarizing plate 113 of another side is set up intersect perpendicularly with the transmission axis 114a of the upper polarizing plate 114 mostly.

[0020]The ferroelectric liquid crystal display device which set up the transmission axis of the polarizing plates 113 and 114 as shown in drawing 4, the time of making the 1st orientation direction 111a carry out orientation of the liquid crystal element -- transmissivity -- most -- it is high (a display. the brightest) -- when the 2nd orientation direction 111b is made to carry out orientation of the liquid crystal element, transmissivity becomes the lowest (a display. most darkly).

[0021]The transmission axis 114a of one polarizing plate 114 is made almost parallel to the 1st orientation direction 111a, and it may be made to make the 1st orientation direction 111a and the transmission axis 115a of the polarizing plate 115 of another side cross at right angles mostly. The transmission axis 114a of one polarizing plate 114 is made into the 1st orientation direction 111a and the intermediate direction of the 2nd orientation direction 111b, and it may be made to make an intermediate direction and the transmission axis 115a of the polarizing plate 115 of another side cross at right angles mostly. The active-matrix type liquid crystal display element which uses MIM as an active element, or a high speed response is possible, and it is usable in the liquid crystal display etc. of the passive-matrix type which can perform a gradation display. Although the ferroelectric liquid crystal display device using a DHF liquid crystal was illustrated, if other ferroelectric liquid crystals and an antiferroelectricity liquid

crystal may be used and high speed response nature can be secured, it is usable in other liquid crystal materials.

[0022]The light filter 13 is a disc-like thing provided with the field of the RGB three primary colors, as shown in drawing 5. Each field is carrying out fanning and the black mask 13A is arranged at the boundary part of each field. Each black mask 13A comprises a filter of optical absorption nature, etc., and as shown in drawing 6 (A) and (B), it has wrap size for the line (horizontal scanning line) of the Mogami end of the liquid crystal display element 11, and the line of a lowermost end.

[0023]The light source 15 is a white light source, and irradiates the liquid crystal display element 11 with a red light, a green light, and a blue light via the light filter 13. The motor 17 comprises a flat motor, a stepping motor, etc., for example. The liquid crystal actuator 19 receives a video signal, and divides this into the video signal for R (gradation signal for R), the video signal for G (gradation signal for G), and the video signal for B (gradation signal for B). The liquid crystal actuator 19 displays monochrome (achromatic color) gradation images for R, monochrome gradation images for G, and monochrome gradation images for B on the liquid crystal display element 11 in order based on these signals. The roll control part 21 receives a video signal, and it drives the motor 17 so that the synchronized signal contained in a video signal may be separated and the field located in its display image and rear-face side may synchronize according to the separated synchronized signal. The rotary place of the light filter 13 may be detected and it may be used for control of the rotation.

[0024]Next, operation of the color liquid crystal display of the RGB field sequential display type of the above-mentioned composition is explained. First, a video signal, for example, the television picture signal whose frame frequency is 60 Hz, is supplied to the liquid crystal actuator 19. The liquid crystal actuator 19 divides the supplied video signal into the video signal for R, the video signal for G, and the video signal for B, and displays monochrome gradation images for R, monochrome gradation images for G, and monochrome gradation images for B on the liquid crystal display element 11 one by one.

[0025]Since the writing of the display image to the liquid crystal display element 11 is performed for every line, For example, if it assumes that monochrome gradation images for R are displayed on the whole screen as shown in drawing 7, monochrome gradation images for G will be written in one by one from the 1st line, monochrome gradation images for G will be displayed, and the whole surface will serve as monochrome gradation images for G after that. Next, monochrome gradation images for B are written in one by one from the 1st line, monochrome gradation images for B are displayed, and the whole surface serves as monochrome gradation images for B after that. Monochrome gradation images for R are written in one by one from the 1st line, monochrome gradation images for R are displayed, and the whole surface serves as monochrome gradation images for R after that. The same

processing as henceforth is performed repeatedly. With the line under writing, if shown in the liquid crystal display element of an active matrix type, a display image, It is the line (line by which the gate pulse is impressed to the gate line 105 of drawing 4 from the line drivers 121) which is writing the indicative data in each pixel via the active element (drawing 4 TFT104), If shown in a simple matrix type liquid crystal display, it is a line in which the scanning electrode which is impressing selection voltage is located. The frame frequency of the liquid crystal display element 11 is set to 180 Hz, 3 times with a frame frequency of 60 Hz of a television picture signal.

[0026]According to the synchronized signal which is contained in a television picture signal and which was level, and separated the Vertical Synchronizing signal, and was separated, the roll control part 21 drives the motor 17 so that each field of the display image and the light filter 13 of the liquid crystal display element 11 may synchronize. Therefore, as mentioned above, the period when each field is located on the liquid crystal display element 11 will be 1 / 180 seconds since the frame frequency of the liquid crystal display element 11 was 180 Hz.

[0027]To the timing which is writing the display image for R in each pixel of the 1st line of the liquid crystal display element 11, here, for example. The roll control part 21 controls rotation of the light filter 13 to locate the field of R on the pixel at the right end of [of the liquid crystal display element 11] the 1st line, and for the black masks 13A to be other pixels of the 1st line, and to be located to be shown in drawing 6 (A). Then, to be shown in drawing 8, the roll control part 21 controls rotation of the light filter 13 by timing which becomes parallel [the line under the top chord of the black mask 13A of a light filter, and writing of the liquid crystal display element 11] so that the lower end of the field of R is located on the line which is writing in the display image. In the timing which the writing of a display image progresses and is writing the display image for R in the line of the lowermost end of the liquid crystal display element 11. The roll control part 21 controls rotation of the light filter 13 to locate the field of R on the pixel at the left end of the line of a lowermost end, and for the black masks 13A to be other pixels of the line of a lowermost end, and to be located to be shown in drawing 6 (B). About the picture of G and B, similarly, the writing of a display image and rotation of the light filter 13 synchronize, and are performed.

[0028]By rotating the light filter 13 as mentioned above, monochrome gradation images for R displayed on the liquid crystal display element 11 are colored R, monochrome gradation images for G are colored G, monochrome gradation images for B are colored B, and, moreover, these are changed and displayed for a short time. For this reason, these pictures are combined on an observer's vision and an observer recognizes a full color image.

[0029]According to such composition, behind the gradation images for R, The field and the black mask of R are located, the field and the black mask of G are located behind the gradation images for G, the field and the black mask of B are located behind the gradation

images for B, and the field of other colors (three primary colors) does not overlap on R, G, and monochrome gradation images for B. For this reason, a foreground color does not blend and a picture can be expressed as a color to display originally. Although the color of each field and the black of a black mask may blend, a display only becomes dark a little and the problem of a foreground color changing is not generated.

[0030]the above-mentioned example -- the line under display image writing -- although it explained that the field of one of RGB was located in part at least, the black mask 13A is located on the line under writing, and it may be made for one field of the RGB to be located after write-in completion The size is arbitrary if the size of the black mask 13A is not limited to these in the size of each black mask 13A although the line of the Mogami end of the liquid crystal display element 11 and a lowermost end is mostly made into wrap size, and mixed colors can be seemingly prevented in the above-mentioned example. However, as for the size of the black mask 13A, since the whole display will become dark if the rate that the black mask 13A in the light filter 13 occupies increases, it is desirable to hold down to necessary minimum.

[0031]Although the above-mentioned example showed the example which arranges a light filter to the rear-face side of the liquid crystal display element 11, a light filter may be arranged to the surface side of the liquid crystal display element 11. Although the example which uses the disc-like light filter 13 was shown, the light filter of conical shape may be used. The example which has arranged the light filter 23 of conical shape to the surface side of the liquid crystal display element 11 is shown in drawing 9. Also in this case, a black mask is arranged to the boundary part of RGB each field. The black mask needs to cover light substantially, just prevents mixed colors, and does not need to be perfect black. A black mask may be created by pasting up a black member for the color of the filter 13 itself on the boundary part of the field well also as black, and the composition is arbitrary. Although the television signal whose frame frequency is 60 Hz was shown as a video signal, arbitrary video signals may be used and rotation of the motor 17 is controlled according to the frame frequency of the video signal.

[0032]

[Effect of the Invention]As explained above, in this invention, the black mask has been arranged between each field of a light filter in the color liquid crystal display of a RGB field sequential display type.

Therefore, even if it is a case where each line of the boundary of the field and a liquid crystal display element is non parallel, a display image can prevent the situation displayed by a different color from a foreground color.

[Translation done.]